REFLECTOR-BASED DEPTH MAPPING OF A SCENE

BACKGROUND

Augmented reality allows interaction among users, real-world objects, and virtual or computer-generated objects and information within an environment. The environment may be, for example, a room equipped with computerized projection and imaging systems that enable presentation of images on various objects within the room and facilitate user interaction with the images and/or objects. The augmented reality may range in sophistication from partial augmentation, such as projecting a single image onto a surface and monitoring user interaction with the image, to full augmentation where an entire room is transformed into another reality for the user's senses. The user can interact with the environment in many ways, including through motion, gestures, voice, and so forth.

Various systems and processes have been used to determine the depth or three-dimensional (3D) orientation of a scene. For instance, the spatial relationships between objects within the scene may be determined in order to create a virtual representation of the scene. Typically, multiple light sources are used to illuminate the scene, which may allow a camera to capture one or more images of the scene. These images may be processed for the purpose of mapping the depth of objects within the scene. However, since different light sources decay at different rates, utilizing multiple independent light sources would likely require an operator of the system to calibrate and recalibrate the system on an ongoing basis. Frequent recalibration of the system would be inefficient, cost-intensive, and would require the consumption of other resources.

BRIEF DESCRIPTION OF THE DRAWINGS

The detailed description is described with reference to the accompanying figures. In the figures, the left-most digit(s) of a reference number identifies the figure in which the reference number first appears. The use of the same reference numbers in different figures indicates similar or identical components or features.

FIG. **1** shows an illustrative scene with an augmented reality environment hosted in an environmental area, such as a room. The augmented reality environment is provided, in part, by three projection and image capture systems that may be configured to generate a three-dimensional (3D) depth map of the environment.

FIG. **2** shows a first implementation of a projection and image capturing system formed as an augmented reality functional node having a chassis to hold a projector and camera in spaced relation to one another. In this implementation, the projector and camera have different optical paths.

FIG. **3** illustrates one example implementation of creating an augmented reality environment by projecting a light pattern on a scene and capturing a corresponding image of the scene.

FIG. **4** shows a second implementation of a projection and image capturing system formed as a familiar type of furniture, such as a table lamp. In this implementation, the projector and camera share a common optical path through a common lens.

FIG. **5** shows a third implementation of a projection and image capturing system, which is formed as a table lamp similar to the embodiment shown in FIG. **4**. In this implementation, the projector and camera share a common optical path through a common lens, and illumination components also share the same optical path.

FIG. **6** shows a first area of illumination and a second area of image capture that may be realized by the implementations shown in FIGS. **4** and **5**.

FIG. **7** shows an exploded view of a head and universal mount of the lamp implementation shown in FIGS. **4** and **5**.

FIG. **8** shows an illustrative system for determining the depth of objects within an environment utilizing a light source, a reflector, a shutter mechanism, and a camera.

FIG. **9** shows an illustrated system for determining the depth of objects within the environment shown in FIG. **8**.

FIG. **10** shows an illustrated system for determining the depth of objects within the environment shown in FIG. **8** based at least in part on a reflector.

FIG. **11** shows an illustrative process of determining the depth of objects within an environment, which may include an enhanced augmented reality environment that includes a projection, reflection, and camera system.

DETAILED DESCRIPTION

This disclosure describes systems and/or processes for determining the three-dimensional (3D) depth of a scene, including objects within the scene, utilizing a light source, a reflector, a shutter mechanism, and a camera. More particularly, the light source may output multiple light beams and may be positioned in close proximity to the reflector (e.g., an ellipsoidal reflector). The shutter mechanism may selectively or alternatively block light being directed at the reflector and light being directed away from the reflector, thus causing the light to illuminate the scene as if the light was being emitted from two different, coaxial points. The camera may be synchronized with the shutter mechanism such that the camera may capture two images of the scene. The first image may represent the scene when the light is being directed away from the reflector and towards the scene and the second image may represent the scene when the light is being directed towards the scene and away from the reflector.

Accordingly, the first image may correspond to a time when the light is being directed away from the reflector and directly at the scene. On the contrary, the second image may represent the scene when the light is being directed at the reflector, which then reflects the light to cause an illumination of the scene. Utilizing these two images, the systems and processes described herein may generate a third image that represents a 3D, and possibly high-definition, depth map of the scene. In particular, the 3D representation or image of the scene may be generated by combining the first image and the second image utilizing a pixel-by-pixel process. In various embodiments, this 3D representation of the scene may map the orientation of the scene, including the spatial relationships between objects within the scene.

As stated above, existing systems typically use multiple light sources to illuminate a scene and then capture an image of the illuminated scene in order to determined depth information of the scene. That is, since the illumination of each of the multiple light sources may be known, these systems may measure the illumination of the scene with respect to each light source to determine the distance between objects within the scene. However, although the relative strength of the illumination for each light source may be initially measured under known conditions, the illumination will change over time due to a variety of reasons (e.g., age of the light sources, manufacture of the light sources, changes in other characteristics within the scene, etc.). As a result, when utilizing multiple different light sources, the system may need to be recalibrated on an ongoing basis.